Final Report

Task 3: Assess Contributions of Onsite Wastewater Treatment Systems Relative to Other Sources

Wekiva Onsite Nitrogen Contribution Study

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Background

The Florida Legislature assigned the Florida Department of Health (FDOH) to conduct the Wekiva Onsite Nitrogen Contribution Study that the Florida Legislature has assigned to the Department. The appropriation language reads:

> "$250,000 in non-recurring tobacco settlement funds are provided to the Department of Health to conduct or contract for a study to further identify and quantify the nitrogen loading from onsite wastewater treatment systems (OWTS) within the Wekiva Study Area. The objectives of the study shall be determined by the Department's Research Review and Advisory Committee, which shall also have oversight of the study. The Department shall provide a report to the Executive Office of the Governor, President of the Senate, and the Speaker of the House of Representatives no later than June 30, 2007. The report shall assess whether OWTS are a significant source of nitrogen to the underlying groundwater relative to other sources and shall recommend a range of possible cost-effective OWTS nitrogen reduction strategies if contributions are significant."

The study was divided into the following tasks:

> Task 1: Field Study to identify and quantify nitrogen loading at a few sample onsite wastewater treatment systems (OWTS) in the Wekiva Study Area
>
> Task 2: Categorization and Quantification of Nitrogen Loading from Onsite Wastewater Treatment System Types
>
> Task 3 (subject to this RFQ): Assessment if OWTS are a significant source of nitrogen to the underlying groundwater relative to other sources; in particular enumeration and aggregation of OWTS loading
>
> Task 4: Recommend a range of possible cost-effective OWTS nitrogen reduction strategies if significant

This is a report of the work conducted under Task 3. The task was divided into five components, plus deliverables:

1. Develop procedures for categorizing OWTS (septic systems) with regard to characteristics that are expected to influence their functioning and environmental impact.
2. Count the number of septic systems in each subcategory for each vulnerability zone, the Wekiva Study area, and the municipalities with area in the Wekiva Study area.
3. Estimate the nitrogen loading from the different subcategories of septic systems to the environment and to the water table.
4. Coordinating with MACTEC, St. John's River Management District's consultant working on the Wekiva Basin nitrogen loading, estimate the nitrogen loading

from other sources of nitrogen, including atmospheric deposition, centralized wastewater facilities, fertilizer applications, and animals.

5. Determine the relative contribution of septic systems to the nitrogen load to the underlying groundwater and assess its significance.

Information for the first three components was obtained from Dr. Richard Otis. MACTEC supplied the data that were the foundation for completion of component 4. Results from the first four components were used to complete component five.

The Study Area

The Wekiva Study Area (WSA) is comprised of about 304,000 acres, covering portions of Lake, Orange, and Seminole Counties. A map of the land uses within the WSA, as identified by the 2004 Land Use Survey, is displayed in Figure 1. The proportions of land designated for categories of land uses are shown in Figure 2.

Figure 1: Map showing land uses within the Wekiva Study Area

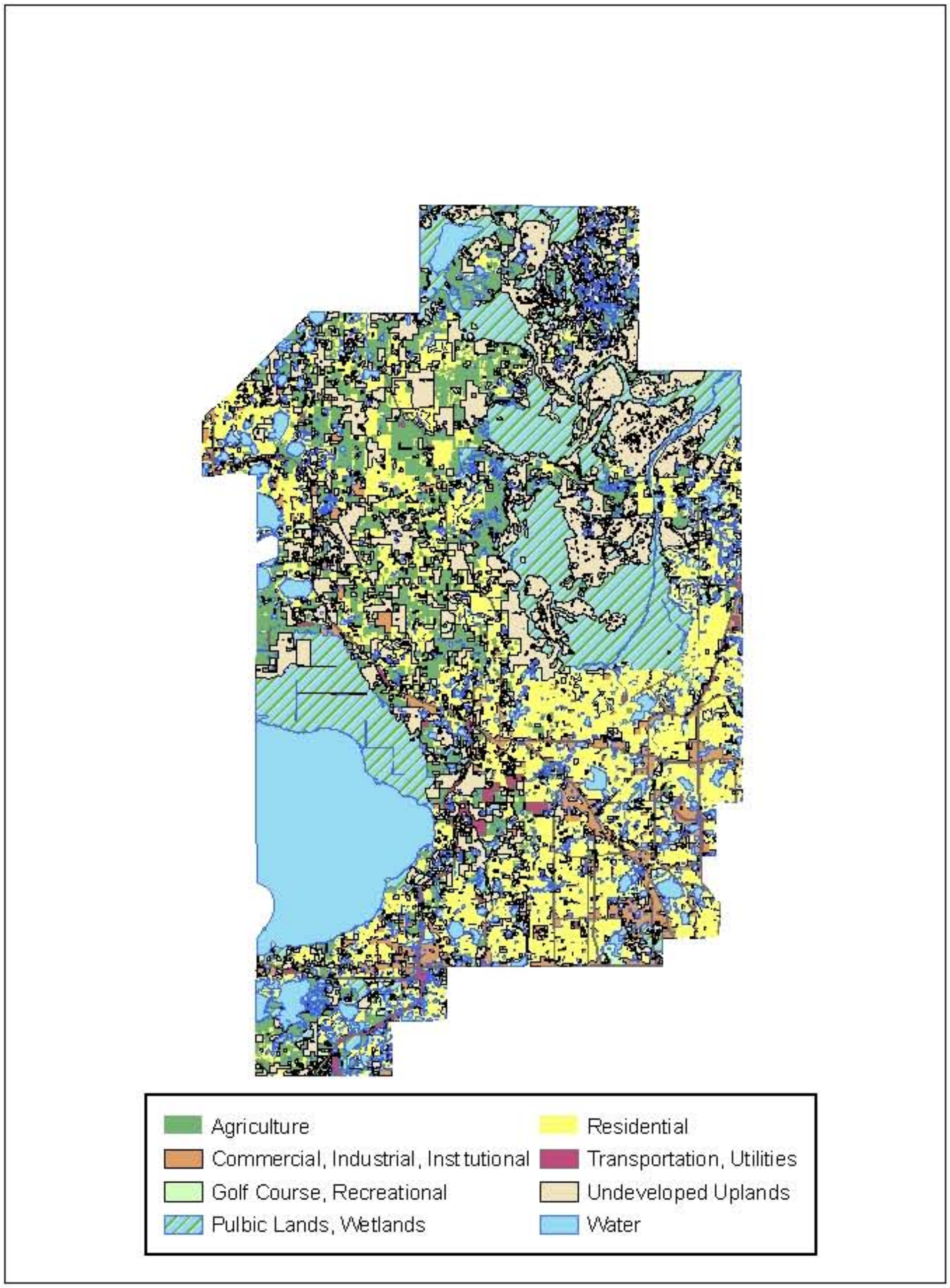
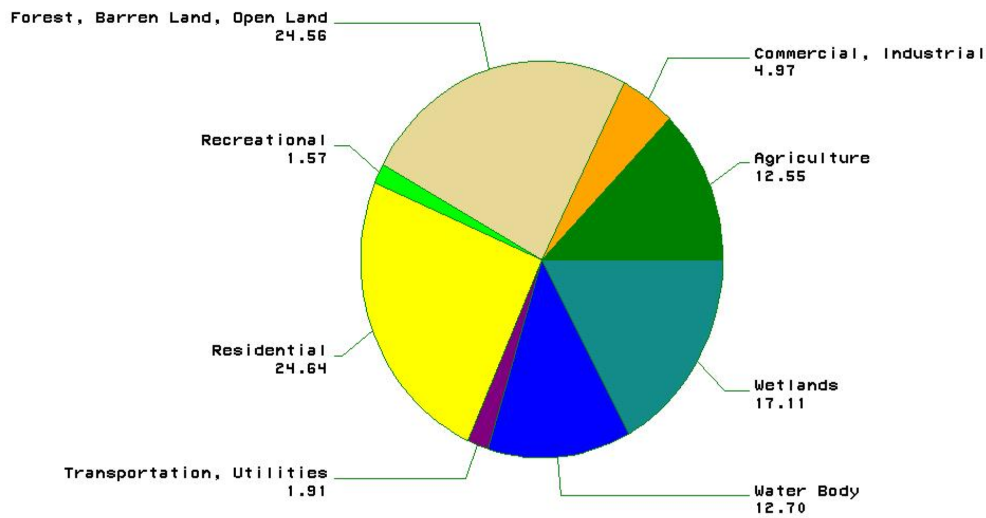


Figure 2. Land Uses in the Wekiva Study Area



Data Sources

GIS coverages with the location of septic systems in the WSA, 2004 Land Use, and Soils were provided by FDOH. Dr. Richard Otis developed the subcategories for the septic systems. He also provided factors for determining nitrogen inputs to the environment and loadings to the groundwater. MACTEC provided sections of its March 2007 report entitled "Phase 1 Report Wekiva River Basin Nitrate Sourcing Study" (referred to as FDEP 2007 Phase1 Report throughout this document) and supplementary materials used in their computations. The full report was obtained from the Florida Department of Environmental Protection (FDEP). The Wekiva Basin encompasses the WSA, but also includes other lands and waters. A major effort in this report went to adjusting the estimates for the Wekiva Basin to obtain those for the WSA.

An important difference exists between the septic system data and data from other sources. For all but septic systems, MACTEC considered ***only nitrates***. MACTEC and Dr. Richard Otis both considered ***total nitrogen*** contributed by septic systems. This makes the relative contributions of septic systems compared to other sources less clear. Inorganic forms of wastewater are nitrate (NO_3), nitrite (NO_2), and ammonia (NH_4). Total Kjehldahl nitrogen (TKN or total nitrogen) is the combination of organic nitrogen and inorganic nitrogen (nitrate, nitrite, and ammonia). Although total nitrogen is probably of most interest, sufficient funding and time were not available to either adjust the MACTEC values or obtain new estimates of total nitrogen from other sources. This may be a worthy future effort. The reader should keep in mind the difference in types of nitrogen being quantified when comparing septic systems to other nitrogen sources.

Inputs represent the nitrogen delivered to the environment. Inputs from direct application of fertilizer, livestock waste (which is assumed to be released to the environment), atmospheric deposition (wet and dry) of total nitrate (nitrate + nitric acid); domestic and industrial wastewater effluents, and septic system discharges are estimated for WSA in this report. Not all nitrogen inputs reach the waters of the WSA. Loadings represent the portion of nitrogen inputs that do reach either the surface waters or ground water. Loading sources from groundwater recharge, atmospheric deposition, centralized wastewater facilities, storm water, and septic systems were considered. Recharge to groundwater was further attributed to fertilizer, livestock, or natural sources. Further, the estimated loadings from centralized wastewater facilities and storm water were separated into the loading to surface waters and that to ground water.

Inputs to the Wekiva Study Area

Inputs to the WSA include direct application of fertilizer, livestock waste (which is assumed to be released to the environment), atmospheric deposition (wet and dry) of total nitrate (nitrate + nitric acid); effluents from centralized wastewater facilities, and septic system discharges. Each source has been quantified. With the exception of septic systems, the methods and results from the FDEP 2007 Phase 1 Report have been followed here. Although a summary of the methods used will be given, the report should be consulted for a fuller explanation. For septic systems, the information was supplied by Dr. Richard Otis. A fuller explanation of the methods he used may be obtained from the final report for Task 2. Again, it should be noted that the estimate for septic systems is for total nitrogen and those for the other sources is for nitrates.

Fertilizer Use

Fertilizer was assumed to be applied at rates recommended by the University of Florida's (UF) Institute of Food and Agricultural Sciences (IFAS) unless it was determined that actual practice deviated from that. The following equation was used to estimate residential, commercial, institutional, and transportation land uses:

$$Fertilizer\ Use_{LU} = \frac{Pervious\ \ Fracton_{LU} \times Application\ \ Rate_{LU} \times Area_{LU}}{CF}$$

where $Fertilizer\ Use_{LU}$ = Nitrate contained in fertilizer applied for a specific land use (LU), totaled for that land use over the entire Wekiva Basin (MT/year);

$Pervious\ Fraction_{LU}$ = Fraction of the land use area that is not paved or under roof;

$Application\ Rate_{LU}$ = Application rate of nitrates in fertilizer (kg/ha/yr);

$Area_{LU}$ = Area within a given land use classification totaled over the entire Wekiva Basin (ha); and

CF = Conversion factor to achieve desired units of measurement, 1000 (kg/MT)

The application rate and impervious fraction by land use are taken from the FDEP 2007 Phase 1 Report's Appendix D, Table 2. These, as well as the total area within each land use and the fertilizer use in kg/year and MT/year, are displayed in Table 1. The estimated total input from fertilizer is estimated to be 5735.39 MT/year.

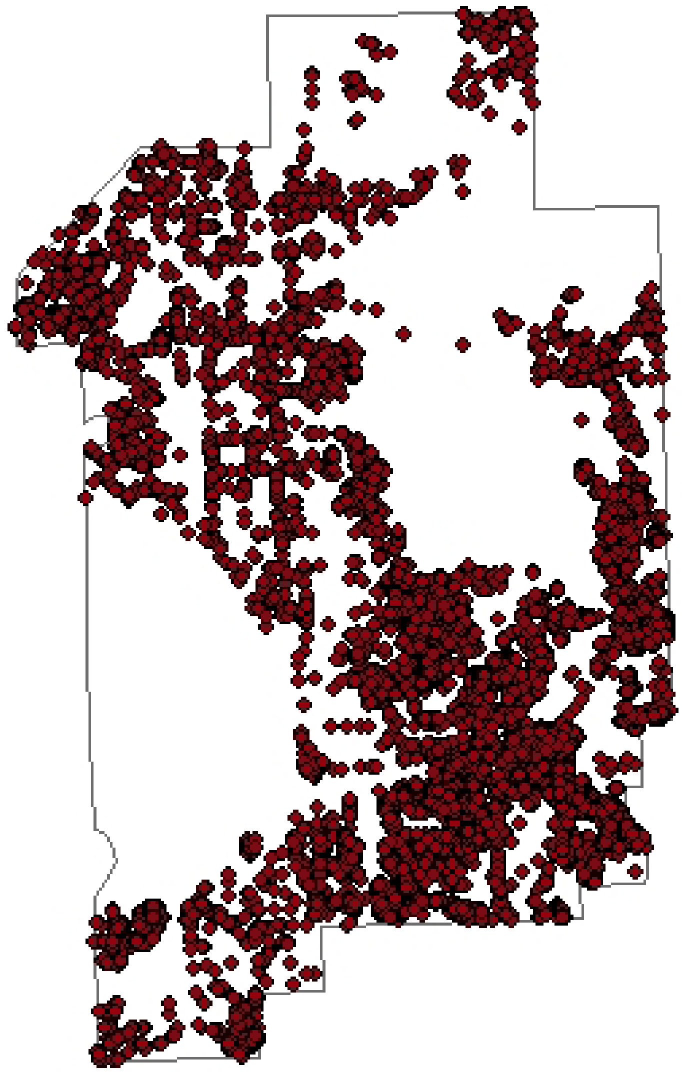
Livestock

From the FDEP 2007 Phase 1 Report, livestock waste on pasture land is 41 kg/ha/year and that on feedlot land uses is taken to be 4100 kg/ha/year. Based on these values, the input of nitrate from land use sources is estimated to be 652.55 MT/year (see Table 2).

Septic Systems

Over 55,000 septic systems are located in the WSA (see Figure 3). Each person living in the household is estimated to discharge 11.2 gms N/day to the septic system (Dr. Richard Otis, e-mail communication). Since an average of 2.6 people live in a household (2000 census), approximately 10.6 kg N/household enter the septic system each year. Assuming that 20% of the total nitrogen is removed in the septic system, Dr. Richard Otis has estimated the contribution of total nitrogen from septic systems to be 8.2 kg/home/year. The distribution of the 55,417 septic systems in the Wekiva Study Area by Drainage Class, Depth to Estimated Seasonal High Water Table Class, Organic Matter Class and Soil Series is shown in Table 3. (Note: Other factors, such as system age and type, affect the nitrogen inputs from septic systems. However, this type of information was not available for the majority of the systems, and only available data were used when deciding on the categories.) The nitrogen contributed by each category as well as the overall totals are also displayed in that table. Thus, the total nitrogen input to the Wekiva Study Area is estimated to be 454.42 MT/year.

Figure 3. Location of Septic Systems Within the Wekiva Studay Area



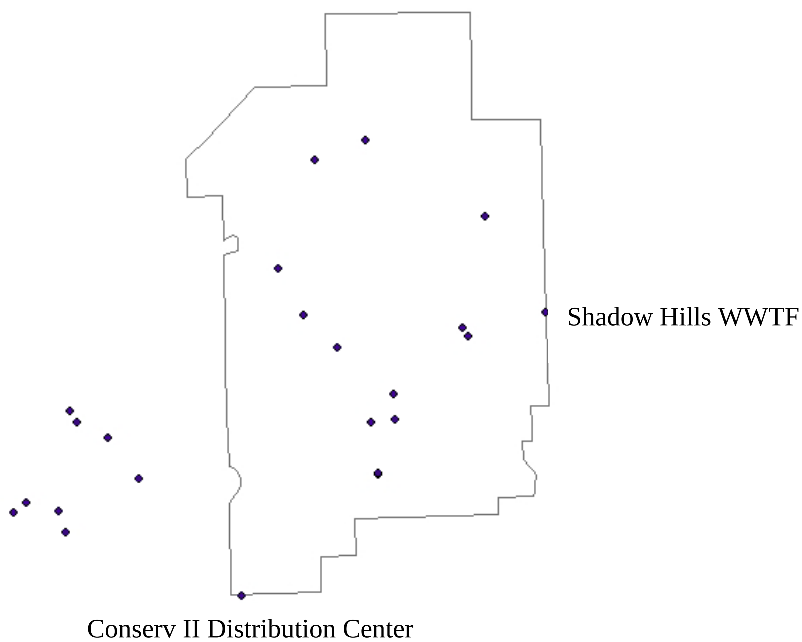
Atmospheric Deposition

According to the FDEP 2007 Phase 1 Report, the nitrate input from acid deposition is estimated to be 2.57 and 4.18 kg/ha/year for rural and urban areas, respectively. The results by Land Use are shown in Table 4. Thus the estimated nitrogen input to WSA from atmospheric deposition is 263.78 MT/year.

Discharge by Centralized Wastewater Facilities

In the FDEP 2007 Phase 1 Report, permitted centralized wastewater discharge facilities within the Wekiva Basin were obtained from the FDEP Wastewater website. Three (3) industrial dischargers with the potential to emit nitrate and 53 permitted domestic dischargers within the Wekiva Basin were identified. MACTEC obtained permit records for the industrial dischargers from FDEP. The largest 26 centralized wastewater facilities were found to account for 99% of the total permitted capacity within the Wekiva Basin, and the permit records for these facilities were obtained from FDEP. Of the facilities reviewed by MACTEC, eleven were located fully within the WSA. Two additional facilities were found to lie just outside the boundary of the WSA (see Figure 4). The facility with the largest input to the Wekiva Basin is one of the two lying just outside the boundary. After consultation with FDOH, it was decided to include the two boundary facilities in the computations, but to also provide estimates for those only within the WSA.

Figure 4. Permitted Centralized Wastewater Facilities with the Two Facilities Lying Immediately Outside the Boundary Identified



Effluents were segregated by disposal type (e.g., sprayfield, percolation basins, rapid infiltration basins (RIBs), suface water discharge), and subsequently separated into two categories: discharge to surface water and discharge to groundwater. In addition, several facilities have a reclamation/reuse disposal system. Wastewater effluent inputs to surface water, groundwater, and reclaimed/reused were estimated as follows:

$$Input = \frac{Actual\ \ Discharge \times Concentration\ \ (NO_3 - N)}{CF}$$

where *Input* = Wastewater facility effluent (MT/yr);
Actual Discharge = Total Annual Discharge;
Concentration $(NO_3 - N)$ = Average effluent concentration of nitrates-nitrogen during 2004 through 2006 (mg/L); and

CF = Conversion factor to achieve desired units of measurement, 10^9 (mg/MT)

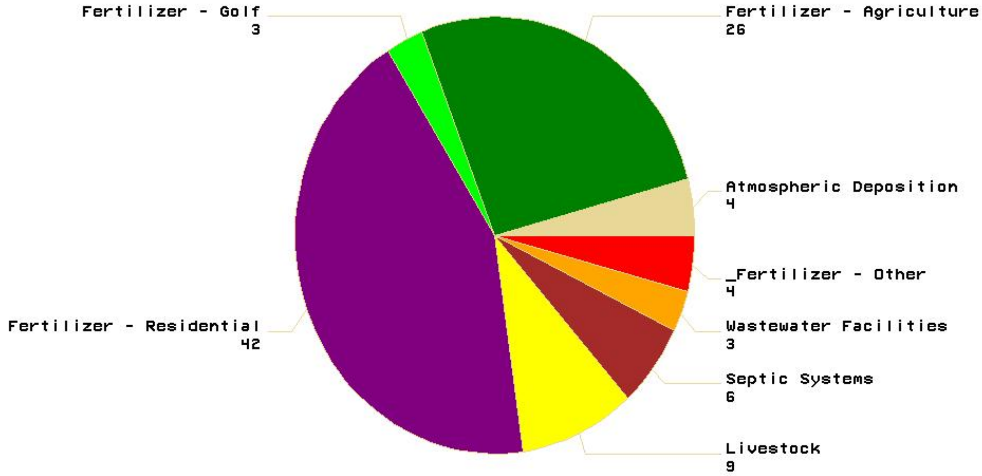
Based on the 26 facilities used to estimate wastewater inputs from the FDEP 2007 Phase 1 Report, total nitrate-nitrogen discharged to surface water from permitted facilities within the WSA was estimated at 8.9 MT/year, and nitrate discharges to groundwater from these same facilities were estimated to be 75.2 MT/year (Table 4). The amount of nitrate-nitrogen that is reclaimed/reused was estimated to be 55.7 MT/year. Effluent reclaimed/reused was assumed to replace or reduce fertilizer and thus provided no additional inputs to the area. If the two boundary facilities are included, the total nitrate-nitrogen discharged to surface water and to groundwater from the 13 facilities was estimated to be 8.9 MT/year and 36.8 MT/year, respectively. The amount of nitrate-nitrogen that is reclaimed/reused was estimated to be 27.3 MT/year.

It should be noted that only 11 facilities within the WSA were included in these computations. According to the report, *A strategy for Water Quality Protection: Wastewater Treatment in the Wekiva Study Area* (FDEP 2004), within WSA, there are 16 centralized wastewater facilities with permits for discharges of 100,000 gallons per day (GPD) or more, and 32 facilities with permits for discharges of less than 1000,000 GPD. Of the 11 considered here, seven have permits for 100,000 GPD or more and four have permits for less than 100,000 GPD. The total permitted capacity in millions of gallons per day is 20.796 for the eleven considered here and 42.502 for all facilities. Because the nitrate-nitrogen concentrations released vary with facility and data on these concentrations are only available for the eleven considered here, the nitrate contributions by the remaining facilities cannot be accurately assessed. An estimate of the nitrate contributions from all facilities within the WSA may be obtained by assuming that the contribution is proportional to the permitted GPD discharge. Using this approach, the nitrate-nitrogen discharged to surface water and to groundwater from the WSA facilities is estimated to be 18.3 MT/year and 75.2 MT/year, respectively. The amount of nitrate-nitrogen that is reclaimed/reused is estimated to be 55.7 MT/year. When the two boundary facilities are also included, the estimated nitrate-nitrogen discharged to surface water, groundwater, and reclaimed/reused is estimated to be 18.3 MT/year, 197.4 MT/year, and 137.0 MT/year, respectively. These last are the estimates used in the remainder of this report.

Total Inputs

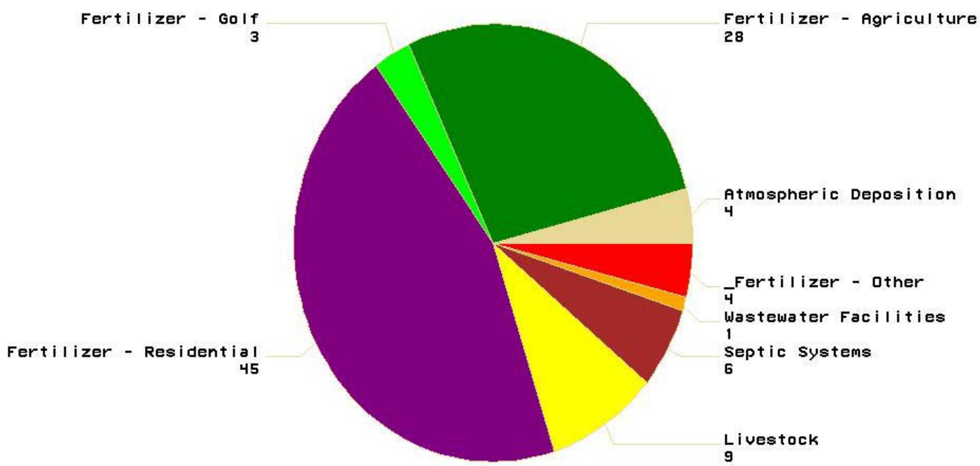
The total of the total nitrogen from septic systems and nitrates from all other sources input to WSA is estimated to be 7,359 MT/year, including the two boundary wastewater facilities, and 7239, if only wastewater facilities within the WSA are included . The relative contributions from all sources both including and excluding the boundary wastewater facilities, are shown in Figures 5 and 6, respectively.

Figure 5. Nitrate* Inputs to Wekiva Study Area by Source, Including Centralized Wastewater Facilities Immediately Outside the WSA



*The input from septic systems is total nitrogen, which includes nitrates.

Figure 6. Nitrate* Inputs to WSA by Source, Including Only Wastewater Facilities Inside the WSA



*The input from septic systems is total nitrogen, which includes nitrates.

Table 1. Nitrate Input to the Wekiva Study Area From Fertilizer Application by Land Use

LU Code	Land Use	Acres	Hectares	Fertilizer (kg/ha/year)	Impervious (%)	Fertilizer Subtotal (kg/year)/	Fertilizer (MT/year)
2150	Agriculture-Field Crops	2627.96	1063.53	150	0.00	159530.20	159.53
2450	Agriculture-Floriculture	21.05	8.52	200	0.00	1703.73	1.70
2510	Agriculture-Horse Farms	2151.10	870.55	63	0.00	54844.55	54.84
2110	Agriculture-Improved Pasture	13267.69	5369.44	63	0.00	338274.46	338.27
2400	Agriculture-Nurseries	5564.90	2252.11	227	0.00	511229.87	511.23
2140	Agriculture-Row Crops	692.64	280.31	630	0.00	176596.17	176.60
2420	Agriculture-Sod Farms	120.32	48.69	200	0.00	9738.40	9.74
2500	Agriculture-Specialty Farms	86.60	35.05	200	0.00	7009.11	7.01
2200	Agriculture-Tree Crops	6016.14	2434.73	227	0.00	552684.54	552.68
8110	Agriculture-Unimproved Pasture	7505.32	3037.40	63	0.00	191356.30	191.36
1480	Airports	172.77	69.92	200	85.00	2097.56	2.10
1400	Commercial	8470.26	3427.91	200	94.25	39420.99	39.42
8200	Communications	128.85	52.15	200	85.00	1564.35	1.56
1820	Golf Courses	3174.04	1284.53	175	0.00	224793.61	224.79
1390	High Density Residential	7792.26	3153.53	148	67.00	154018.34	154.02
1700	Institutional	3311.45	1340.14	200	91.00	24122.57	24.12
1100	Low Density Residential	12739.00	5155.48	148	14.70	650847.79	650.85

LU Code	Land Use	Acres	Hectares	Fertilizer (kg/ha/year)	Impervious (%)	Fertilizer Subtotal (kg/year)/	Fertilizer (MT/year)
1200	Medium Density Residential	44361.16	17952.96	148	27.80	1918381.69	1918.38
1800	Recreational	1807.25	731.39	200	1.50	144084.76	144.08
8100	Transportation	3319.16	1343.26	200	85.00	40297.94	40.30
8300	Utilities	2197.99	889.53	200	85.00	26685.81	26.69
1100	Very Low Density Residential	9906.01	4008.96	148	14.70	506107.39	506.11
	Totals	**135,433.91**	**54,810.10**			**5,735,390.12**	**5,735.39**

Table 2. Nitrate Input to the Wekiva Study Area From Livestock Waste by Land Use

Land Use	Acres	Hectares	Livestock Waste (kg/ha/year)	Livestock Waste Subtotal (kg/year)	Livestock Waste (MT/year)
Agriculture-Feeding Operations	162.06	65.59	4150	269458.29	269.458
Agriculture-Horse Farms	2151.10	870.55	41	35335.56	35.336
Agriculture-Improved Pasture	13267.69	5369.44	41	217945.40	217.945
Agriculture-Unimproved Pasture	7505.32	3037.40	41	123288.13	123.288
Totals	**23,086.17**	**9,342.97**		**652,552.91**	**652.55**

Table 3. Total Nitrogen Input to the Wekiva Study Area from Septic Systems

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
	<=3.5 Feet	<= 1%		434	3.559
	<=3.5 Feet	<= 1%	**URBAN LAND**	8070	66.174
	> 3.5 Feet	<= 1%	**PITS**	17	0.139
Excessively Well/ Somewhat Excessively Well	> 3.5 Feet	<= 1%	**LAKE FINE SAND** Hyperthermic, coated Typic Quartzipsamments	1126	9.233
			PAOLA FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	412	3.378
			ST. LUCIE SAND Hyperthermic, uncoated Typic Quartzipsamments	542	4.444
		> 1%	**ASTATULA FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	2585	21.197
			CANDLER SAND Hyperthermic, uncoated Lamellic Quartzipsamments	22146	181.597
Well	> 3.5 Feet	<= 1%	**APOPKA SAND** Loamy, siliceous, hyperthermic Grossarenic Paleudults	52	0.426
		> 1%	**ORLANDO FINE SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	194	1.591
Moderately Well	<=3.5 Feet	<= 1%	**POMELLO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	934	7.659
	> 3.5 Feet	<= 1%	**ARCHBOLD SAND** Hyperthermic, uncoated Typic Quartzipsamments	133	1.091
			ORSINO FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	63	0.517
			UDORTHENTS	2	0.016
		> 1%	**FLORAHOME SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	185	1.517
			MILLHOPPER SAND Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults	8	0.066
			TAVARES FINE SAND Hyperthermic, uncoated Typic Quartzipsamments	10120	82.984

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
Somewhat Poorly/ Poorly/Very Poorly	<=3.5 Feet	<= 1%	**ADAMSVILLE FINE SAND** Hyperthermic, uncoated Aquic Quartzipsamments	158	1.296
			ARENTS	316	2.591
			CASSIA FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	117	0.959
			ZOLFO FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	702	5.756
		>1%	**ANCLOTE SAND** Sandy, siliceous, hyperthermic Typic Endoaquolls	19	0.156
			BASINGER FINE SAND Siliceous, hyperthermic Spodic Psammaquents	959	7.864
			BRIGHTON MUCK Dysic, hyperthermic Typic Haplohemists	64	0.525
			CANOVA MUCK Fine-loamy, siliceous, superactive, hyperthermic Histic Glossaqualts	2	0.016
			CHOBEE FINE SANDY LOAM Fine-loamy, siliceaous, superactive, hyperthermic Typic Argiaquolls	4	0.033
Somewhat Poorly/ Poorly/Very Poorly	<=3.5 Feet	>1%	**EAUGALLIE FINE SAND** Sandy, siliceous, hyperthermic Alfic Alaquods	49	0.402
			EMERALDA FINE SAND Fine, mixed, superactive, hyperthermic Mollic Albaqualfs	17	0.139
			FELDA FINE SAND Loamy, siliceous, superactive, hyperthermic Arenic Endoaqualfs	27	0.221
			GATOR MUCK Loamy, siliceous, euic, hyperthermic Terric Haplosaprists	1	0.008
			IMMOKALEE FINE SAND Sandy, siliceous, hyperthermic Arenic Alaquods	433	3.551

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
			MALABAR FINE SAND Loamy, siliceous, active, hyperthermic Grossarenic Endoaqualfs	6	0.049
			MYAKKA FINE SAND Sandy, siliceous, hyperthermic Aeric Alaquods	645	5.289
			NITTAW SANDY CLAY Fine, smectitic, hyperthermic Typic Argiaquolls	128	1.050
			OCOEE MUCK Sandy or sandy skeletal, siliceous, dysic, hyperthermic Terric Haplohemists	1	0.008
			OKEELANTA MUCK Sandy or sandy skeletal, siliceous, euic, hyperthermic Terric Haplosaprists	3	0.025
			ONA FINE SAND Sandy, siliceous, hyperthermic Typic Alaquods	851	6.978
			PLACID FINE SAND Sandy, siliceious, hyperthermic Typic Humaquepts	45	0.369
			POMPANO FINE SAND Siliceous, hyperthermic Typic Psammaquents	202	1.656
			SAMSULA MUCK Sandy or sandy skeletal, siliceous, dysic, hperthermic Terric Haplosaprists	88	0.722
			SANIBEL	68	0.558
			SEFFNER FINE SAND Sandy, siliceous, hyperthermic Aquic Humic Dystrudepts	152	1.246
			SMYRNA SAND Sandy, siliceous, hyperthermic Aeric Alaquods	2657	21.787
			SPARR FINE SAND Loamy, siliceous, subactive, hyperthermic Grossarenic Paleudults	22	0.180

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	Total Nitrogen (MT/year)
			ST. JOHNS FINE SAND Sandy, siliceous, hyperhtermic TypicAlaquods	287	2.353
			WABASSO FINE SAND Sandy over loamy, siliceous, active, hyperthermic Alfic Alaquods	339	2.780
			WAUBERG FINE SAND Loamy, siliceous, active, hyperthermic Arenic Albaqualfs	2	0.016
			WAUCHULA FINE SAND Sandy over loamy, siliceous, active hyperthermic Ultic Alaquods	1	0.008
	> 3.5 Feet	> 1%	**LOCHLOOSA FINE SAND** Loamy, siliceous, semiactive, hyperthermic Aquic Arenic Paleudults	29	0.238
Totals				**55,417**	**454.42**

Table 4. Nitrate Input to the Wekiva Study Area From Atmospheric Deposition by Land Use

Land Use	**Acres**	**Hectares**	**Atmospheric Deposition (kg/ha/year)**	**Atmospheric Deposition (kg/year)**	**Atmospheric Deposition (MT/hyear)**
Agriculture-Aquaculture	15.23	6.16	2.57	15.69	0.0157
Agriculture-Feeding Operations	162.06	65.59	2.57	166.87	0.1669
Agriculture-Field Crops	2627.96	1063.53	2.57	2705.95	2.7060
Agriculture-Floriculture	21.05	8.52	2.57	21.67	0.0217
Agriculture-Horse Farms	2151.10	870.55	2.57	2214.94	2.2149
Agriculture-Improved Pasture	13267.69	5369.44	2.57	13661.46	13.6615
Agriculture-Nurseries	5564.90	2252.11	2.57	5730.05	5.7301
Agriculture-Row Crops	692.64	280.31	2.57	713.20	0.7132
Agriculture-Sod Farms	120.32	48.69	2.57	123.89	0.1239
Agriculture-Specialty Farms	86.60	35.05	2.57	89.17	0.0892
Agriculture-Tree Crops	6016.14	2434.73	2.57	6194.69	6.1947
Agriculture-Unimproved Pasture	7505.32	3037.40	2.57	7728.06	7.7281
Airports	172.77	69.92	2.57	178.79	0.1788
Barren Land	9427.61	3815.35	2.57	9756.43	9.7564
Cemetaries	203.70	82.44	4.18	342.86	0.3429
Commercial	8266.56	3345.48	4.18	2097.61	2.0976
Communications	128.85	52.15	4.18	32.70	0.0327
Extractive	634.46	256.77	2.57	98.98	0.0990

Land Use	Acres	Hectares	Atmospheric Deposition (kg/ha/year)	Atmospheric Deposition (kg/year)	Atmospheric Deposition (MT/hyear)
Forest	33070.72	13383.72	2.57	34224.18	34.2242
Golf Courses	3174.04	1284.53	2.57	2740.04	2.7400
High Density Residential	7792.26	3153.53	4.18	3822.71	3.8227
Industrial	2714.17	1098.42	2.57	423.44	0.4234
Institutional	3311.45	1340.14	2.57	1205.46	1.2055
Low Density Residential	12739.00	5155.48	2.57	9274.70	9.2747
Marinas and Fish Camps	28.89	11.69	2.57	29.89	0.0299
Medium Density Residential	44361.16	17952.96	4.18	47277.33	47.2773
Open Land	20202.82	8176.08	2.57	20907.47	20.9075
Recreational	1807.25	731.39	2.57	1870.29	1.8703
Swimming Beaches	2.38	0.96	2.57	2.46	0.0025
Transportation	3319.16	1343.26	2.57	0.00	0.0000
Tree Plantations	12098.73	4896.36	2.57	12457.80	12.4578
Utilities	2197.99	889.53	4.18	557.73	0.5577
Very Low Density Residential	9906.01	4008.96	2.57	8654.55	8.6545
Water Body	38687.88	15656.99	2.57	29172.88	29.1729
Wetlands	52103.30	21086.21	2.57	39288.87	39.2889
Totals	**304,582.15**	**123,364.40**		**263,782.80**	**263.78**

Table 5. Surface Water, Groundwater, and Reuse Nitrate Discharge for Wekiva Study Area's Centralized Wastewater Facilities

Facility ID	**Name**	**Surface Water (MT/Yr)**	**Ground Water (MT/Yr)**	**Reused (MT/Yr)**
FL0036251	Sanlando Utilities; Wekiva Hunt Club	7.69606	5.435	16.6769
FLA010818	Apopka WRF – Project Arrow	0.00000	1.326	4.3988
FLA010798	OCUD/Northwest Water Reclamation Facility	1.24337	25.986	0.0000
FLA010815	Ocoee, City of	0.00000	1.198	6.1892
FLA010865	Zellwood Station MHP	0.00000	1.325	0.0000
FLA295965	Eustis – Eastern	0.00000	0.699	0.0000
FLA010851	Clarcona Resort Condo	0.00000	0.497	0.0000
FLA010541	Wekiva Falls Resort	0.00000	0.274	0.0000
FLA010498	Seminole Springs Elementary School WWTF	0.00000	0.017	0.0000
FLA010833	Monterey Mushroom Farm (Terry Farms)	0.00000	0.025	0.0000
FLA010855	Coca-Cola/Apopka Facility	0.00000	0.015	0.0000
Totals of above (facilities in WSA)		**8.9**	**36.8**	**27.3**
FLA010795	Conserv II Distribution Center	0.00000	121.403	81.2544
FLA011105	Shadow Hills WWTF	0.00000	0.831	0.0000
Total including two facilities immediately outside WSA		**8.9**	**159.0**	**108.5**

Facility ID	Name	Surface Water (MT/Yr)	Ground Water (MT/Yr)	Reused (MT/Yr)
FL0036251	Sanlando Utilities; Wekiva Hunt Club	7.69606	5.435	16.6769
FLA010818	Apopka WRF – Project Arrow	0.00000	1.326	4.3988
FLA010798	OCUD/Northwest Water Reclamation Facility	1.24337	25.986	0.0000
FLA010815	Ocoee, City of	0.00000	1.198	6.1892
FLA010865	Zellwood Station MHP	0.00000	1.325	0.0000
FLA295965	Eustis – Eastern	0.00000	0.699	0.0000
FLA010851	Clarcona Resort Condo	0.00000	0.497	0.0000
FLA010541	Wekiva Falls Resort	0.00000	0.274	0.0000
FLA010498	Seminole Springs Elementary School WWTF	0.00000	0.017	0.0000
FLA010833	Monterey Mushroom Farm (Terry Farms)	0.00000	0.025	0.0000
FLA010855	Coca-Cola/Apopka Facility	0.00000	0.015	0.0000
Totals		**8.9**	**36.8**	**27.3**

Loadings to Waters of the Wekiva Study Area

Only a portion of the nitrate input to the Wekiva Study Area will reach ground and surface waters. As an example, a portion of the total nitrogen in fertilizers and wastewater effluents is volatilized as ammonia. A significant portion of nitrate applied as land fertilizer is used by plants in the root zone. Denitrification converts nitrate to nitrite, which is released to the atmosphere. The nitrate or, in the case of septic systems, total nitrogen delivered to waters of the Basin will be referred to here as loading.

In MACTEC's FDEP 2007 Phase 1 Report, information was considered sufficient to support estimation and portioning of loads to groundwater at the water table and to surface water. The portion of the groundwater load (at the water table) that eventually reaches the Floridian aquifer is expected to be significant (FDEP 2007 Phase 1 Report), but that portion cannot be quantified with the available time and resources.

Nitrate loadings to the groundwater from natural sources; septic systems; wastewater facilities; groundwater recharge, as a function of land use; and storm water, as a function of land use, are quantified. The groundwater recharge contribution was partitioned into that from atmospheric deposition and that from the primary source for the corresponding land use. Storm water and wastewater nitrate contributions to the surface waters were also estimated.

Groundwater Recharge

Various land use contributions to groundwater loadings were estimated by multiplying shallow groundwater concentrations (CGW) representative for each land use by the recharge rate (by location) using the following equation:

$$Groundwater\ Loading_{LU} = \frac{Recharge \times CGW_{LU} \times Area_{LU}}{CF}$$

where $Groundwater\ Loading_{LU}$ = Amount of NO3-N reaching the water table from a specific land use (MT/year)

$Recharge$ = Downwared flow of water to the Floridian aquifer (inch/year);

CGW_{LU} = Concentration of nitrate in recharging groundwater, estimated from concentrations near the water table (mg/L);

$Area_{LU}$ = Area within a given land use classification totaled over the entire Wekiva Basin (ha); and

CF = Conversion factor to achieve desired units of measurement, 3937 (mg inch ha/kg L)

The WSA land use (Figure 1) and recharge rate (Figure 7) coverages were overlaid in a Geographic Information System (GIS), and the area for each land use-recharge rate combination was determined. The recharge rates were not available for a small portion of the WSA (Figure 8). The land uses in these areas were assigned recharge rates proportional to those observed in the region for which recharge rates are available.

In the FDEP 2007 Phase 1 Report, the groundwater concentration for each land use was estimated from relevant technical literature. The results of the groundwater load calculations, by land use, are displayed in Table 6. The estimated total of groundwater loading from recharge is 647.15 MT/year.

Groundwater nitrate loadings may be partitioned into that from atmospheric deposition and that from activities consistent with the land use. According to the FDEP 2007 Phase 1 Report, atmospheric deposition accounted for groundwater concentrations of 0.1 mg/L. Based on this and the recharge information, the atmospheric contribution to groundwater loading was estimated for each land use and totals 23.9 MT/year (Table 7). The remaining portion of each land use's groundwater recharge nitrate loading, if any, was attributed to the primary nitrate source for that land use. For most land uses, fertilizer use was assumed to be the source. For pasture, groundwater loadings were proportionately assigned to livestock waste and fertilizer use.

Figure 7. Recharge Rates Within the Wekiva Study Area

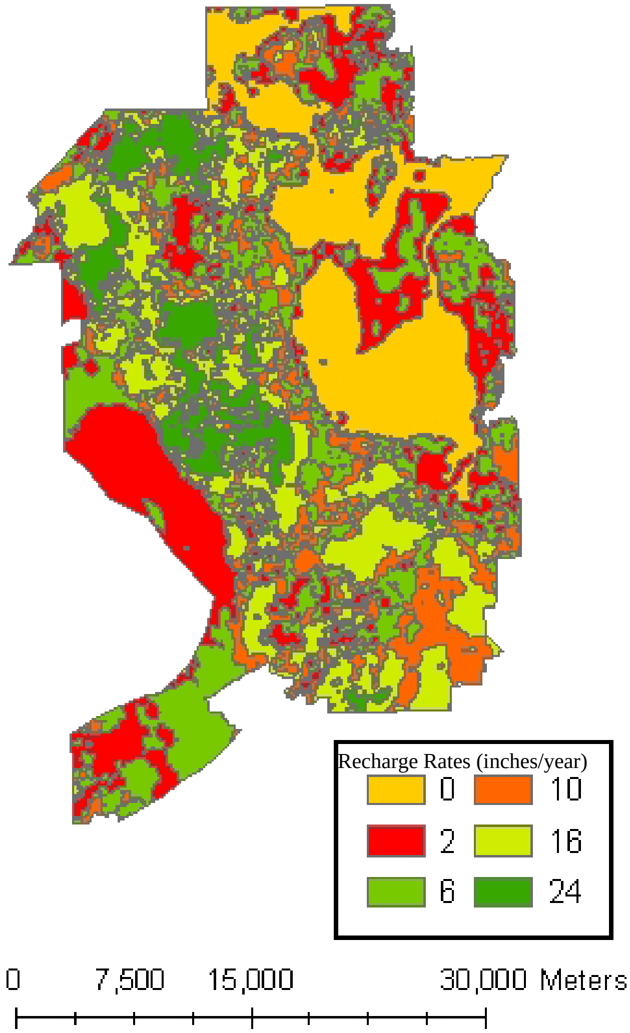
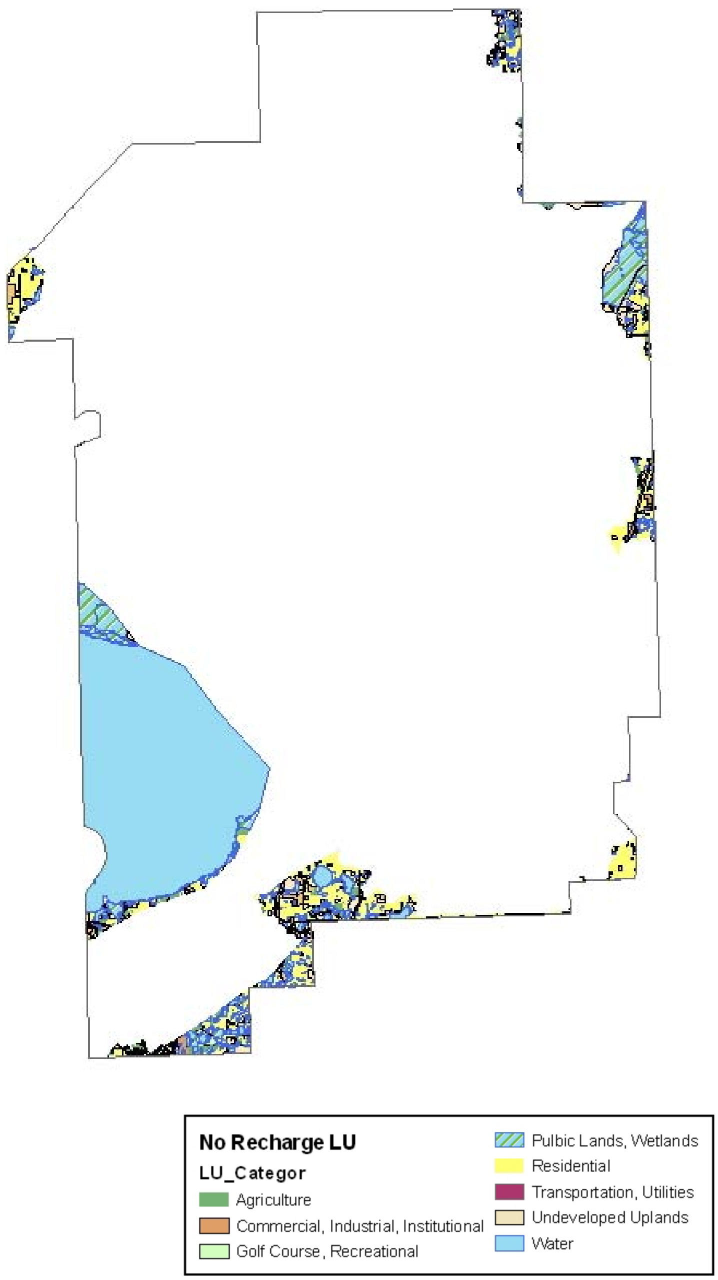


Figure 8. Areas Within the Wekiva Study Area Without Recharge Information



Storm Water

In developing the FDEP 2007 Phase 1 Report, MACTEC worked with the storm water pollutant loading model developed by CDM (2005) using the Watershed Management Model (WMM). Storm water run-off volumes and pollutant loadings within basins are estimated using the WMM. MACTEC updated the loading estimates to the 2004 land use baseline, extended the WSA results to include all of the Wekiva Basin, partitioned loadings by land use and source type, and distinguished between direct storm water loadings to surface waters and diffuse storm water loadings to groundwater. It was assumed that the loadings by land use, as determined by the CDM (2005) WMM application, were valid. MACTEC ran the WMM model for each land use to assess the respective contributions. For these runs, the sub-basins in the Wekiva Basin were identified as either open or closed. An open basin is one with an outlet, and it is assumed these basins deliver their loadings to surface water. Closed basins have no outlet and are assumed to deliver storm water loadings to groundwater.

Use of the WMM was beyond the scope of this work. To obtain the storm water loadings for the WSA, the contribution of each land use was assumed to be that proportion of the Wekiva Basin land use acres lying within the WSA. That is, the number of acres for each land use was determined for the Wekiva Basin and for the WSA. The proportion of the area associated with that land use lying in the WSA was determined. That proportion of the Wekiva Basin storm water loadings was taken as the estimate of the loadings for both direct and diffuse loadings. These results are displayed in Table 8.

Again following the approach in the FDEP 2007 Phase 1 Report, direct storm water loading to surface water by land use was taken as BMP-treated load from open basins. (BMP – best management practices). Diffuse storm water loading to groundwater by land use is untreated load in the WSA minus loading to surface water. This calculation is based on the conservative assumption that treatment by BMPs reduces the direct loading to surface water, but that all the nitrate-nitrogen treatment efficiency represents a true recycling of nitrate-nitrogen.

To partition storm water loadings by source type, it was assumed that nitrate-nitrogen loading from undeveloped lands was from "natural" sources. The storm water loading from the Forest/Open land use category was taken as this natural or undeveloped loading. After subtracting the natural or undeveloped loading that would be associated with each land use, any remaining loading was assigned to the most relevant source, such as fertilizer. The total fertilizer nitrate loads were the sum of the loads from groundwater recharge, after accounting for atmospheric deposition, and from storm water, after accounting for natural sources (see Table 9).

Septic Systems

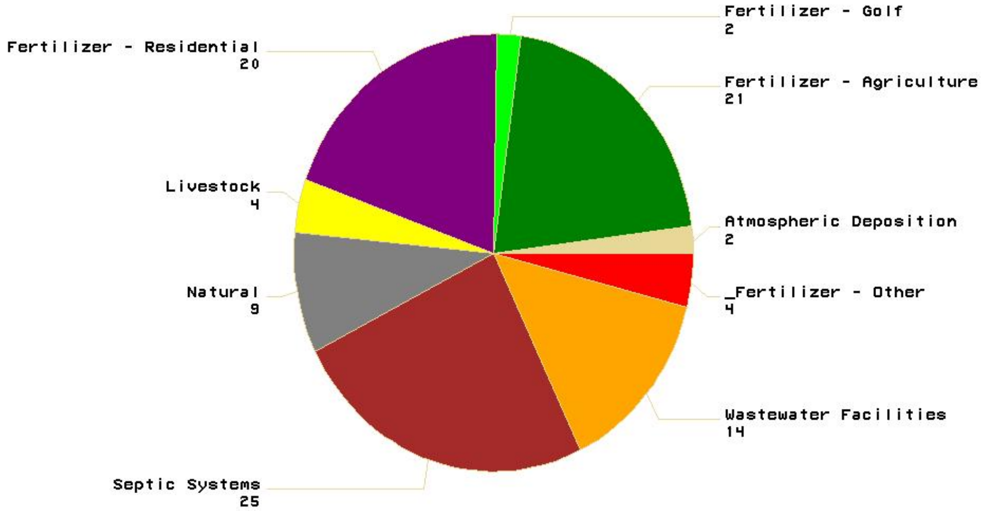
Dr. Richard Otis provided the information for determining the groundwater loadings from septic systems. These loadings were found by multiplying the total nitrogen inputs to the environment by the proportion of that amount anticipated to reach groundwater. That proportion depended on soil drainage, water level class, organic matter class, and soil series as shown in Appendix A. For poorly drained soils, the percentages of TKN and NO_3 (nitrate) removed by the soil differed. Whether TKN or NO_3 is appropriate depends upon septic system type, and Dr. Richard Otis supplied that information as shown in Appendix A. Using this information, the low, medium, and high estimates of groundwater nitrogen loadings due to septic systems for each soil series are displayed in Table 10, and the estimated low, medium and high estimated groundwater loadings of total nitrogen from septic systems are 348.9, 373.7, and 406.2 MT/year, respectively.

Totals

The loadings to waters of the WSA were separated into the following categories: Fertilizer due to agriculture, golf, residential areas, and other sources; Livestock; Atmospheric Deposition, Natural Sources, Wastewater Facilities, and Septic Systems. For the septic systems, consideration was given to the low, medium and high estimates. Graphs of the relative contributions of each of these sources, including the boundary centralized wastewater facilities are included, and for low, medium, and high estimates of the contribution of the septic systems are displayed in Figures 9, 10, and 11, respectively. Similar, graphs of the relative contributions of each of the sources, including only the centralized wastewater facilities within the WSA, and for low, medium, and high estimates of the contribution of septic systems are displayed in Figures 12, 13, and 14.

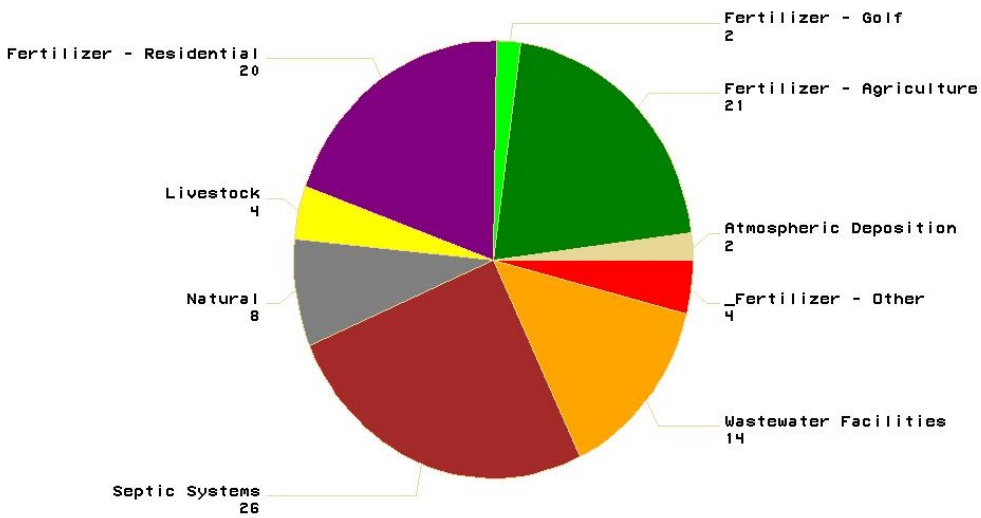
In constructing the graphs in Figures 9 to 14, only the loadings to groundwater from fertilizer, livestock, natural sources, atmospheric deposition, and septic systems are considered. Only that portion (diffuse) of storm water estimated to impact groundwater is included. The estimated nitrate loadings to surface waters from centralized wastewater facilities or from storm water are not included. In Figure 15, these additional sources are included for the median contribution from septic systems and for the boundary centralized wastewater facilities as well as those fully within the WSA.

Figure 9. Nitrate* Groundwater Loadings to the Wekiva Study Area by Source, Including Centralized Wastewater Facilities Immediately Outside the Area and Using Low Estimates for Septic Systems



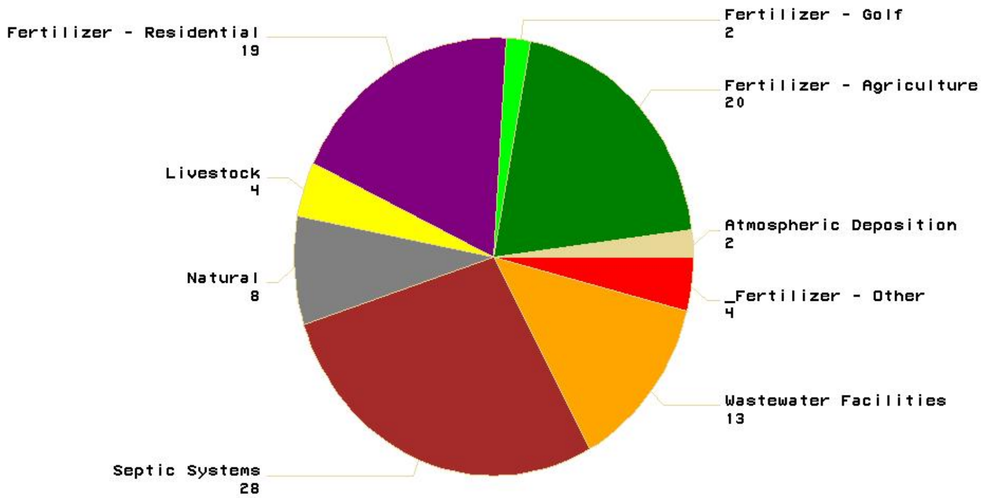
*The input from septic systems is total nitrogen, which includes nitrates.

Figure 10. Nitrate* Groundwater Loadings to the Wekiva Study Area by Source, Including Centralized Wastewater Facilities Immediately Outside the Area and Using Median Estimates for Septic Systems



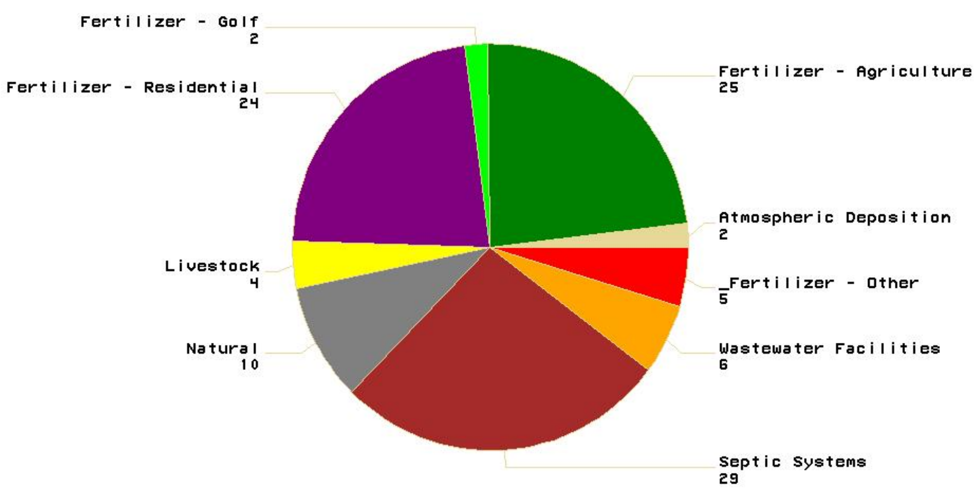
*The input from septic systems is total nitrogen, which includes nitrates.

Figure 11. Nitrate* Groundwater Loadings to the Wekiva Study Area by Source, Including Centralized Wastewater Facilities Immediately Outside the Area and Using High Estimates for Septic Systems



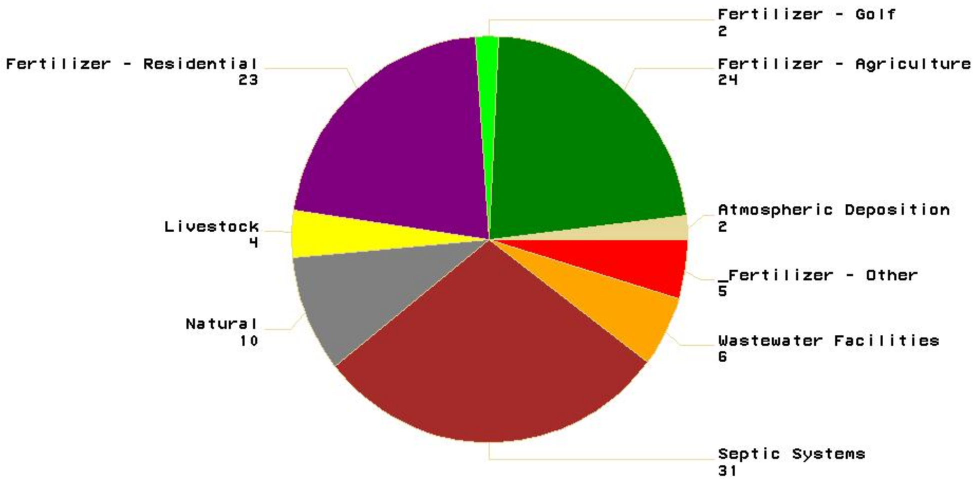
*The input from septic systems is total nitrogen, which includes nitrates

Figure 12. Nitrate* Groundwater Loadings to the Wekiva Study Area by Source, Including Only Centralized Wastewater Facilities Within the Area and Using Low Estimates for Septic Systems



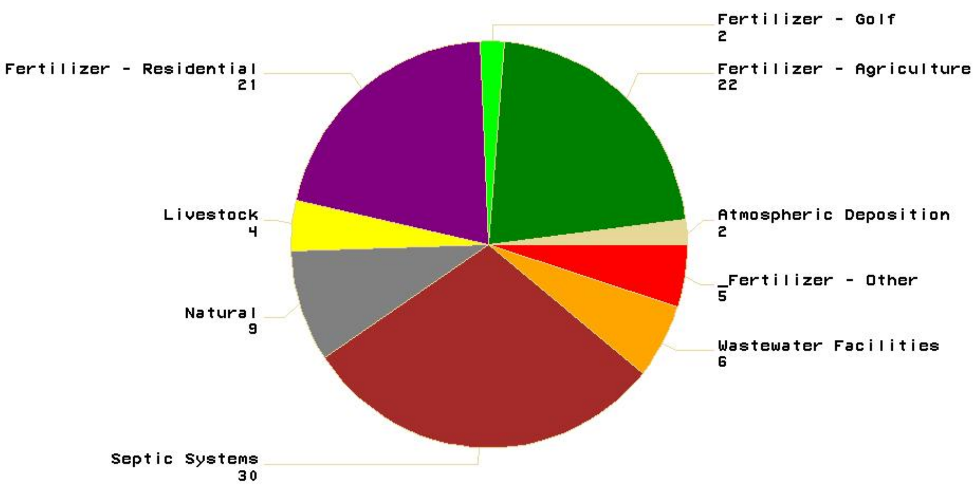
*The input from septic systems is total nitrogen, which includes nitrates.

Figure 13. Nitrate* Groundwater Loadings to the Wekiva Study Area by Source, Including Only Centralized Wastewater Facilities Within the Area and Using Median Estimates for Septic Systems



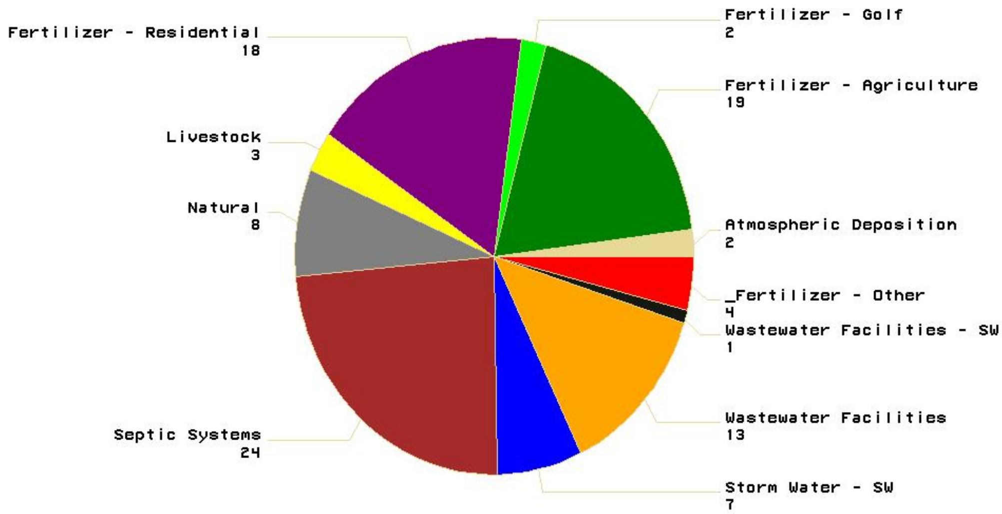
*The input from septic systems is total nitrogen, which includes nitrates.

Figure 14. Nitrate* Groundwater Loadings to the Wekiva Study Area by Source, Including Only Centralized Wastewater Facilities Within the Area and Using High Estimates for Septic Systems



*The input from septic systems is total nitrogen, which includes nitrates

Figure 15. Nitrate* Loadings to the Wekiva Study Area by Source, Including Centralized Wastewater Facilities Immediately Outside the Area and Using Median Estimates for Septic Systems



*The input from septic systems is total nitrogen, which includes nitrates.

Table 6. Nitrate Loads to the Wekiva Study Area From Groundwater (GW) Recharge by Land Use

LU Code	Description	Acres	Hectares	Nitrate Loads From GW Recharge (MT/Year)
1100	Low Density Residential	22645.01	9164.44	78.808
1200	Medium Density Residential	44361.16	17952.96	136.897
1300	High Density Residential	7792.26	3153.53	25.262
1400	Commercial	8470.26	3427.91	29.277
1500	Industrial	2714.17	1098.42	0.347
1600	Extractive	634.46	256.77	0.104
1700	Institutional	3311.45	1340.14	11.954
1800	Recreational	1836.14	743.08	5.081
1820	Golf Course	3174.04	1284.53	26.653
1900	Open Land	2841.58	1149.99	0.237
2100	Crop Land and Pasture Land	59.31	24.00	0.263
2110	Agriculture-Improved Pasture	13267.69	5369.44	80.194
2120	Agriculture-Unimproved Pasture	4225.56	1710.09	18.565
2130	Woodland Pasture	3279.75	1327.32	20.762
2140	Agriculture-Row Crops	692.64	280.31	8.680
2150	Agriculture-Field Crops	2568.65	1039.53	11.256
2200	Agriculture-Tree Crops	6016.14	2434.73	104.798
2300	Agriculture-Feeding Operations	162.06	65.59	3.037
2400	Agriculture-Nurseries	128.83	52.14	1.228
2410	Agriculture-Sod Farms	82.90	33.55	0.714
2420	Agriculture-Floriculture	120.32	48.69	0.156
2430	Agriculture-Ornamentals	5353.17	2166.43	45.068
2450	Agriculture-Horse Farms	21.05	8.52	0.113
2500	Agriculture-Specialty Farms	101.83	41.21	1.160
2510	Agriculture-Horse Farms	2151.10	870.55	9.843
2600	Other Open Lands—rural	265.72	107.54	0.023

LU Code	Description	Acres	Hectares	Nitrate Loads From GW Recharge (MT/Year)
3000	Upland Nonforested	17095.53	6918.56	1.327
4000	Upland Forests (25% forested cover)	45169.45	18280.08	3.761
5000	Water	38687.88	15656.99	1.890
6000	Wetlands	52103.30	21086.21	1.139
7000	Barren land	9427.61	3815.35	0.276
8000	Transportation, Communication, and Utilities	5818.77	2354.86	18.274
Totals		**304,582.15**	**123,374.40**	**647.15**

Table 7. Nitrate Loads to the Wekiva Study Area From Atmospheric Deposition by Land Use

LU	Description	Acres	Hectares	Nitrate Loads from Atmospheric Deposition (MT/Year)
1100	Low Density Residential	22645.01	9164.44	2.62692
1200	Medium Density Residential	44361.16	17952.96	4.56323
1300	High Density Residential	7792.26	3153.53	0.84207
1400	Commercial	8470.26	3427.91	0.97589
1500	Industrial	2714.17	1098.42	0.34709
1600	Extractive	634.46	256.77	0.10390
1700	Institutional	3311.45	1340.14	0.39847
1800	Recreational	1836.14	743.08	0.16938
1820	Golf Course	3174.04	1284.53	0.33316
1900	Open Land	2841.58	1149.99	0.23729
2100	Crop Land and Pasture Land	59.31	24.00	0.00658
2110	Agriculture-Improved Pasture	13267.69	5369.44	1.45807
2120	Agriculture-Unimproved Pasture	4225.56	1710.09	0.33754
2130	Woodland Pasture	3279.75	1327.32	0.37748
2140	Agriculture-Row Crops	692.64	280.31	0.03774
2150	Agriculture-Field Crops	2568.65	1039.53	0.28140
2200	Agriculture-Tree Crops	6016.14	2434.73	0.69865
2300	Agriculture-Feeding Operations	162.06	65.59	0.01687
2400	Agriculture-Nurseries	128.83	52.14	0.02047
2410	Agriculture-Sod Farms	82.90	33.55	0.01191
2420	Agriculture-Floriculture	120.32	48.69	0.00390
2430	Agriculture-Ornamentals	5353.17	2166.43	0.75113
2450	Agriculture-Horse Farms	21.05	8.52	0.00188
2500	Agriculture-Specialty Farms	101.83	41.21	0.01934
2510	Agriculture-Horse Farms	2151.10	870.55	0.22371
2600	Other Open Lands—rural	265.72	107.54	0.02319

LU	Description	Acres	Hectares	Nitrate Loads from Atmospheric Deposition (MT/Year)
3000	Upland Nonforested	17095.53	6918.56	1.32749
4000	Upland Forests (25% forested cover)	45169.45	18280.08	3.76089
5000	Water	38687.88	15656.99	1.89029
6000	Wetlands	52103.30	21086.21	1.13921
7000	Barren land	9427.61	3815.35	0.27550
8000	Transportation, Communication, and Utilities	5818.77	2354.86	0.60913
Totals		**304,582.15**	**123,374.40**	**23.87**

Table 8. Diffuse and Direct Storm Water (SW) Nitrate Loads to the Wekiva Study Area by Land Use

LU Code	Description	Acres	Hectares	% of WSA in Wekia Basin	Wekiva Basin		Wekiva Study Area (WSA)	
					SW Direct	SW Diffuse	SW Direct	SW Diffuse
1100	Low Density Residential	22645.01	9164.44	71	10.07	24.57	7.1208	17.3741
1200	Medium Density Residential	44361.16	17952.96	90	28.75	31.81	25.8595	28.6118
1300	High Density Residential	7792.26	3153.53	87	8.24	10.06	7.1912	8.7795
1400	Commercial	8470.26	3427.91	86	14.28	6.67	12.3328	5.7605
1500	Industrial	2714.17\	1098.42	84	2.11	1.85	1.7727	1.5543
1600	Extractive	634.46	256.77	29	0.00	2.17	0.0000	0.6226
1700	Institutional	3311.45	1340.14	92	4.94	4.92	4.5525	4.5341
1800	Recreational	1838.51	744.05	66	0.30	0.12	0.1968	0.0787
1820	Golf Course	3174.04	1284.53	78	0.82	2.02	0.6434	1.5850
1900	Open Land	2841.58	1149.99	90	2.08	2.56	1.8819	2.3161
2110	Improved pastures (monolcult. Planted forage crops)	13267.69	5369.44	47	5.69	11.30	2.6754	5.3133
2140	Row crops	692.64	280.31	84	0.00	0.10	0.0000	0.0844
2150	Field crops	2568.65	1039.53	70	0.32	0.97	0.2252	0.6827
2200	Tree crops	6016.14	2434.73	48	0.24	2.89	0.1148	1.3819
2300	Feeding operations	162.06	65.59	100	0.03	0.04	0.0300	0.0400
2400	Nurseries and vineyards	128.83	52.14	82	0.52	2.17	0.4267	1.7808

LU Code	Description	Acres	Hectares	% of WSA in Wekia Basin	Wekiva Basin		Wekiva Study Area (WSA)	
					SW Direct	SW Diffuse	SW Direct	SW Diffuse
2500	Specialty farms	101.83	41.21	79	0.32	0.92	0.2539	0.7301
4000	Upland Forests (25% forested cover)	45169.45	18280.08	60	9.41	6.97	5.6115	4.1564
5000	Water	38687.88	15656.99	100	2.94	3.07	2.9400	3.0700
6000	Wetlands	52103.30	21086.21	72	32.19	13.63	23.0402	9.7558
7000	Barren land	9427.61	3815.35	92	0.14	0.29	0.1283	0.2657
8000	Transportation, Communication, and Utilities	5818.77	2354.86	78	3.11	6.56	2.4163	5.0967
Totals					**126.5**	**135.7**	**103.6**	**99.4**

Table 9. Nitrate Loads to the Wekiva Stuy Area From Fertilizer and Natural Sources

LU Code	Description	Fertilizer Nitrate Loads From Groundwater (MT/Year)	Fertilizer Nitrate Loads From Storm Water (MT/Year)	Total Fertilizer Nitrate Loads (MT/Year)	Nitrate Loads from Natural Sources (MT/Year)
1100	Low Density Residential	76.181	12.4434	88.624	12.0515
1200	Medium Density Residential	132.334	28.4885	160.822	25.9828
1300	High Density Residential	24.420	8.5763	32.996	7.3944
1400	Commercial	28.301	9.7161	38.017	8.3772
1500	Industrial	0.000	0.7486	0.749	2.5784
1600	Extractive	0.000	0.1401	0.140	0.4825
1700	Institutional	11.556	6.4060	17.962	2.6805
1800	Recreational	4.912	0.0000	4.912	0.2756
1820	Golf Courses	26.320	1.0385	27.358	1.1900
1900	Open Land	0.000	0.0000	0.000	4.1980
2100	Crop Land and Pasture Land	0.257	0.0000	0.257	0.0000
2110	Agriculture-Improved Pasture	78.736	3.7227	82.458	4.2660
2120	Agriculture-Unimproved Pasture	18.227	0.0000	18.227	0.0000
2130	Woodland Pastures	20.384	0.0000	20.384	0.0000
2140	Agriculture-Row Crops	8.642	0.0393	8.681	0.0450
2150	Agriculture-Field Crops	10.975	0.4231	11.398	0.4848

LU Code	Description	Fertilizer Nitrate Loads From Groundwater (MT/Year)	Fertilizer Nitrate Loads From Storm Water (MT/Year)	Total Fertilizer Nitrate Loads (MT/Year)	Nitrate Loads from Natural Sources (MT/Year)
2200	Agriculture-Tree Crops	104.099	0.6974	104.797	0.7992
2300	Agriculture-Feeding Operations	3.021	0.0326	0.000	0.0374
2400	Agriculture-Nurseries	1.207	1.0287	2.236	1.1789
2410	Tree Nurseries	0.703	0.0000	0.703	.
2420	Agriculture-Sod Farms	0.152	0.0000	0.152	.
2430	Agriculture-Ornamentals	44.317	0.0000	44.317	.
2450	Agriculture-Floriculture	0.111	0.0000	0.111	.
2500	Agriculture-Specialty Farms	1.141	0.4586	1.599	0.5255
2510	Agriculture-Horse Farms	9.620	0.0000	9.620	.
2600	Other Open Lands-Rural	0.000	0.0000	0.000	.
3000	Upland Non-Forested	0.000	0.0000	0.000	.
4000	Forest	0.000	0.0000	0.000	9.7679
5000	Water	0.000	0.0000	0.000	6.0100
6000	Wetlands	0.000	7.3791	7.379	25.4169
7000	Barren Lands	0.000	0.0000	0.000	0.3939
8000	Communications & Utilities	17.665	1.6904	19.355	5.8226
Totals		**623.28**	**83.03**	**703.25**	**119.96**

Table 10. Total Nitrogen Loads to the Wekiva Study Area From Septic Systems

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Median Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
	<=3.5 Feet	<= 1%		434	2.927	2.408	2.280
			URBAN LAND	8070	54.421	44.773	42.398
			PITS	17	0.139	0.132	0.125
Excessively Well/ Somewhat Excessively Well	>3.5 Feet	<= 1%	**LAKE FINE SAND** Hyperthermic, coated Typic Quartzipsamments	1126	9.233	8.772	8.310
			PAOLA FINE SAND Hyperthermic, uncoated Spodic Quartzipsamments	412	3.378	3.209	3.041
			ST. LUCIE SAND Hyperthermic, uncoated Typic Quartzipsamments	542	4.444	4.222	4.000
		>1%	**ASTATULA FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	2585	21.197	20.137	19.077
			CANDLER SAND Hyperthermic, uncoated Lamellic Quartzipsamments	22146	181.597	172.517	163.437
Well	>3.5 Feet	<= 1%	**APOPKA SAND** Loamy, siliceous, hyperthermic Grossarenic Paleudults	52	0.426	0.405	0.384
		>1%	**ORLANDO FINE SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	194	1.591	1.511	1.432
Moderately	<=3.5 Feet	<= 1%	**POMELLO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	934	6.893	5.361	3.829
			ARCHBOLD SAND Hyperthermic, uncoated Typic Quartzipsamments	133	1.036	0.982	0.927

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Median Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
Well	>3.5 Feet	<= 1%	**ORSINO FINE SAND** Hyperthermic, uncoated Spodic Quartzipsamments	63	0.491	0.465	0.439
			UDORTHENTS	2	0.015	0.012	0.010
		>1%	**FLORAHOME SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	185	1.365	1.289	1.214
			MILLHOPPER SAND Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults	8	0.059	0.056	0.052
			TAVARES FINE SAND Hyperthermic, uncoated Typic Quartzipsamments	10120	78.835	74.686	70.536
Somewhat Poorly/ Poorly/Very Poorly	<=3.5 Feet	<= 1%	**ADAMSVILLE FINE SAND** Hyperthermic, uncoated Aquic Quartzipsamments	158	1.231	1.166	1.101
			ARENTS	316	1.814	1.425	1.036
			CASSIA FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	117	0.863	0.815	0.768
			ZOLFO FINE SAND Sandy, siliceous, hyperthermic Oxyaquic Alorthods	702	5.469	4.893	4.317
		>1%	**ANCLOTE SAND** Sandy, siliceous, hyperthermic Typic Endoaquolls	19	0.039	0.019	0.000
			BASINGER FINE SAND Siliceous, hyperthermic Spodic Psammaquents	959	7.471	6.881	6.291
			BRIGHTON MUCK Dysic, hyperthermic Typic Haplohemists	64	0.052	0.026	0.000

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Median Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			CANOVA MUCK Fine-loamy, siliceous, superactive, hyperthermic Histic Glossaqualts	2	0.002	0.001	0.000
			CHOBEE FINE SANDY LOAM Fine-loamy, siliceaous, superactive, hyperthermic Typic Argiaquolls	4	0.030	0.026	0.023
			EAUGALLIE FINE SAND Sandy, siliceous, hyperthermic Alfic Alaquods	49	0.321	0.281	0.241
			EMERALDA FINE SAND Fine, mixed, superactive, hyperthermic Mollic Albaqualfs	17	0.014	0.007	0.000
			FELDA FINE SAND Loamy, siliceous, superactive, hyperthermic Arenic Endoaqualfs	27	0.133	0.111	0.089
			GATOR MUCK Loamy, siliceous, euic, hyperthermic Terric Haplosaprists	1	0.007	0.007	0.006
			IMMOKALEE FINE SAND Sandy, siliceous, hyperthermic Arenic Alaquods	433	2.840	2.485	2.130
			MALABAR FINE SAND Loamy, siliceous, active, hyperthermic Grossarenic Endoaqualfs	6	0.044	0.039	0.034
			MYAKKA FINE SAND Sandy, siliceous, hyperthermic Aeric Alaquods	645	3.173	2.645	2.116

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Median Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			NITTAW SANDY CLAY Fine, smectitic, hyperthermic Typic Argiaquolls	128	0.105	0.052	0.000
			OCOEE MUCK Sandy or sandy skeletal, siliceous, dysic, hyperthermic Terric Haplohemists	1	0.008	0.007	0.007
			OKEELANTA MUCK Sandy or sandy skeletal, siliceous, euic, hyperthermic Terric Haplosaprists	3	0.023	0.022	0.020
			ONA FINE SAND Sandy, siliceous, hyperthermic Typic Alaquods	851	6.280	5.583	4.885
			PLACID FINE SAND Sandy, siliceious, hyperthermic Typic Humaquepts	45	0.037	0.018	0.000
			POMPANO FINE SAND Siliceous, hyperthermic Typic Psammaquents	202	0.994	0.828	0.663
			SAMSULA MUCK Sandy or sandy skeletal, siliceous, dysic, hperthermic Terric Haplosaprists	88	0.072	0.036	0.000
			SANIBEL	68	0.530	0.502	0.474
			SEFFNER FINE SAND Sandy, siliceous, hyperthermic Aquic Humic Dystrudepts	152	0.125	0.062	0.000
			SMYRNA SAND Sandy, siliceous, hyperthermic Aeric Alaquods	2657	2.179	1.089	0.000

Drainage	Water Class	Organic Matter	Soil Series	Number of Septic Systems	High Estimate of Nitrogen to GW (MT/Yr)	Median Estimate of Nitrogen to GW (MT/Yr)	Low Estimate of Nitrogen to GW (MT/Yr)
			SPARR FINE SAND Loamy, siliceous, subactive, hyperthermic Grossarenic Paleudults	22	0.018	0.009	0.000
			ST. JOHNS FINE SAND Sandy, siliceous, hyperhtermic TypicAlaquods	287	1.883	1.647	1.412
			WABASSO FINE SAND Sandy over loamy, siliceous, active, hyperthermic Alfic Alaquods	339	2.224	1.946	1.668
			WAUBERG FINE SAND Loamy, siliceous, active, hyperthermic Arenic Albaqualfs	2	0.010	0.008	0.007
			WAUCHULA FINE SAND Sandy over loamy, siliceous, active hyperthermic Ultic Alaquods	1	0.008	0.007	0.007
	>3.5 Feet	> 1%	**LOCHLOOSA FINE SAND** Loamy, siliceous, semiactive, hyperthermic Aquic Arenic Paleudults	29	0.143	0.119	0.095
Totals				**55,417**	**406.2**	**373.7**	**348.9**

Limitations

The FDEP 2007 Phase 1 Report identified a number of limitations, both from procedural issues and uncertainties in input parameters. These apply here as well. Only a few of these will be identified here, and the interested reader should refer to the report for a fuller discussion.

The parameters used in all of the computations are subject to uncertainty. As an example, the estimated amount of fertilizer applied to each land use was based on the technical literature and surely varies over the WSA. The atmospheric deposition was assumed to be the same for all rural and all urban lands. Because these uncertainties have not been quantified, it is not know how much uncertainty is associated with any of these estimates.

The nitrate effluent concentrations were available for only a portion of the centralized wastewater facilities. The permitted, and not the actual, discharge rates from the wastewater facilities were used in the computations for all but the 13 for which data were available. One of the two facilities just outside the WSA is the centralized wastewater facility with the largest contribution to nitrates in the groundwater in the Wekiva Basin. How much these two facilities impact the WSA is unclear.

The limitations of the septic system parameters are discussed by Dr. Richard Otis in his final report for Task 2. In addition, error is undoubtedly present in the location of at least some of the septic systems. For each septic system, the soil series associated with the corresponding map unit in the soils maps was assigned to the system, and any error in this assignment would affect the estimates of nitrogen loadings. Further, the septic system loadings were estimated in terms of total nitrogen whereas the inputs and loads from other sources included only nitrate.

Conclusions

Fertilizer is the major source of nitrate inputs to the WSA, accounting for 78 percent of all inputs. Although constituting a smaller portion, fertilizer is also the primary source of nitrate loadings to the groundwater of the WSA, accounting for an estimated 45 to 47 percent of all loadings. Among the sources of fertilizer, agriculture is the primary factor (24 percent) followed closely by residential use (23 percent). Livestock contribute nine percent of the inputs but only four percent of the nitrate loadings to the WSA.

Even though septic systems constitute only six to eight percent of the inputs, they are estimated to contribute 25 to 28 percent of the nitrate loadings to groundwater of the WSA. This estimate is based on total nitrogen while that from other sources considers only nitrates; however, the load contribution from septic systems is substantial.

The nitrate loading from natural sources is estimated to be nine to ten percent. The nitrate loadings from septic tanks is 250% that of natural, and the nitrate loadings from fertilizer is more than 400% that of natural.

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Appendix A

Information from Dr. Richard Otis

ESTIMATED DENITRIFICATION POTENTIAL OF SOILS IN THE WEKIVA STUDY AREA

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Execessively / Somewhat Excessively	2	1	**LAKE FINE SAND** Hyperthermic, coated Typic Quartzipsamments	Excessively drained, rapidly to very rapidly permeable soils formed in thick beds of sand. Water table is >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	1	**PAOLA FINE SAND** Hyperthermic, uncoated Spodic Quartzipsamments	Very deep, excessively drained, very rapidly permeable upland soils that formed in sandy marine deposits. Water table is >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	1	**ST. LUCIE SAND** Hyperthermic, uncoated Typic Quartzipsamments	Very deep, excessively darined, very rapidly permeable soils formed in marine eolian sand. Water table >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	2	**ASTATULA FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	Very deep, excessively drained, rapidly permeable soils formed in eolian and marine sands. Water table >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	2	**CANDLER SAND** Hyperthermic, uncoated Lamellic Quartzipsamments	Very deep, excessively drained, rapidly permeable soils that formed in thick beds of eolian or marine deposits of coarse textured materials. Short, thin loamy lamella exist below 70". Water table >80" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
Well	2	1	**APOPKA SAND** Loamy, siliceous, hyperthermic Grossarenic Paleudults	Very deep, well drained, moderately permeable soils that formed in thick beds of sandy and loamy marine or eolian deposits. Water table >60" deep.	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	
	2	2	**ORLANDO FINE SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	Very deep, well drained, rapidly permeable soils that formed in thick deposits of sandy marine or fluvial sediments. Water table >72".	Slight	TKN/NO_3	<10%	Very low organic content Very low moisture content (aerobic)	

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Moderately Well	2	1	**ARCHBOLD SAND** Hyperthermic, uncoated Typic Quartzipsamments	Deep, well drained, very rapidly permeable sandy soils that formed in marine or eolian deposits. Seasonally high water table (June-November) at 42-60" but 60-80" the remainder of the year.	Moderate: wetness	TKN/NO_3	5-15%	Very low organic content Low moisture content (aerobic)	
	2	1	**ORSINO FINE SAND** Hyperthermic, uncoated Spodic Quartzipsamments	Very deep, moderately well drained, very rapidly permeable soils that formed in thick beds of sandy marine or eolian deposits. Water table at 50-60" deep. Spodic horizon at 25".	Severe: wetness	TKN/NO_3	5-15%	Very low organic content Low moisture content (aerobic)	
	2	2	**FLORAHOME SAND** Siliceous, hyperthermic Humic Psammentic Dystrudepts	Deep, moderately well drained, dark sufaced, rapidly permeable soils that formed in sandy marine and eolian deposits. Water table depth at 48-72" for 4-6 months each year receeding to >72 in dry periods.	Moderate: wetness	TKN/NO_3	10-20%	Low organic content Low moisture content (aerobic) Fluctuating water table	
	2	2	**MILLHOPPER SAND** Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults	Very deep, moderately well drained, moderately permeable soils that formed in thick beds of sandy and loamy marine sediments. Water table depth is 48-60" for 1-4 months and 60-72" for 2-4 months most years.	Moderate: wetness	TKN/NO_3	10-20%	Low organic content Low moisture content (aerobic) Fluctuating water table	
	2	2	**TAVARES FINE SAND** Hyperthermic, uncoated Typic Quartzipsamments	Very deep, moderately well drained, rapidly permeable soils that formed in sand marine or eolian deposits. Zones of saturation at depths of 40-80".	Moderate: wetness	TKN/NO_3	5-15%	Low organic content Low moisture content (aerobic)	
Somewhat Poorly / Poorly /Very Poorly	1	1	**ADAMSVILLE FINE SAND** Hyperthermic, uncoated Aquic Quartzipsamments	Very deep, somewhat poorly drained, rapidly permeable soils that formed in thick sandy marine sediments. Water table is at 20-40" for 2-6 months of most years and 10-20" for up two weeks in some years. It is within 60" for more than 9 months in most years.	Severe: wetness poor filter	TKN NO3	5-15% 15-30%	Very low organic content below 4" Rapid permeability Fluctuating water table with aquic regime (anoxic)	
	1	1	**CASSIA FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	Very deep, somewhat poorly drained, moderately rapid permeable soils formed in sandy materials. Water table is at 18-42" for about 6 months during most years and will drop to >42" during the driest season.	Severe: wetness	TKN NO3	10-20% 5-25%	Fine sand with shallow water table High organic content in spodic horizon at 2-3 ft. Fluctuating water table	
	1	1	**POMELLO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	Very deep, moderately well to somewhat poorly drained soils, which are sandy to depths of >80" that formed in sandy marine sediments. Seasonally high water table is at depths of about 24-42" for 1-4 months during most years.	Severe: ponding poor filter	TKN NO3	10-40% 10-50%	Freely draining Shallow, fluctuating water table at 2-3 ft Spodic horizon high in organic content at 3.5 ft	

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	1	**ZOLFO FINE SAND** Sandy, siliceous, hyperthermic Oxyaquic Alorthods	Very deep, somewhat poorly drained soils that forme in thick beds of sandy marine deposits. Water table is at depths of 24-40" for 2-6 months of the year and up to 1024" deep for short periods. It is within 60" for more than 9 months most years.	Severe: wetness poor filter	TKN	5-25%	Fine sand with shallow water table (2-3.5ft) Spodic horizon at 5-8 ft Fluctuating water table	
						NO3	15-35%		
	1	2	**ANCLOTE SAND** Sandy, siliceous, hyperthermic Typic Endoaquolls	Very deep, very poorly drained, rapidly permeable fine sandy soils in depressions, drainage way and floodplains. Water table is within 10" of the surface for 6 or more months during most years and rededes to >20" during the driest season.	Severe: ponding wetness poor filter	TKN	5-20%	Very shallow water table (<1ft) High organic content in surface horizon	
						NO3	>75%		
	1	2	**BASINGER FINE SAND** Siliceous, hyperthermic Spodic Psammaquents	Very deep, poorly drained and very poorly drained, rapidly permeable soils fromed in sandy marine sediments. Found in sloughs, depressions, and low flats. Water table at depths of <12" 2-6 months annually and 12-30" for periods >6 months. Surface ponding is common.	Severe: wetness ponding poor filter	TKN	5-20%	Very shallow fluctuating water table Very high organic content	
						NO3	>75%		
	1	2	**BRIGHTON MUCK** Dysic, hyperthermic Typic Haplohemists	Very deep, very poorly drained, moderately rapid to rapidly permeable organic soils in depressions, freshwater marshes and swamps. Organic layer is >54" thick. Water table is above ground surface for 4-6 months.	Severe: subsides flooding wetness	TKN	20-40%	Deep organic surface horizon Very shallow, fluctuating water table	
						NO3	>90%		
	1	2	**CANOVA MUCK** Fine-loamy, siliceous, superactive, hyperthermic Histic Glossaqualfs	Very deep, very poorly drained, moderately slowly permeable fine sandy and loamy soils in depressions and fresh water swamps and marshes. They are formed in loamy marine sediments. Water table is at the surface or within 10" of the surface for more than 9 month during most years. The soil may be flooded for 36 months.	Severe: ponding	TKN	20-40%	Very shallow water table (<1ft) High organic content in surface horizon and the Btg horizon at 32-43"	
						NO3	>90%		
	1	2	**CHOBEE FINE SANDY LOAM** Fine-loamy, siliceaous, superactive, hyperthermic Typic Argiaquolls	Very deep, very poorly drained, slowly to vry slowly permeable soils in depressions, flats, and river flood plains that formed in thick beds of loamy marine sediments. Water table within 6" for 1-4 months of the year.	Severe: flooding wetness percs slowly	TKN	10-30%	Very shallow water table High organic content in the surface horizon	
						NO3	>90%		
	1	2	**EAUGALLIE FINE SAND** Sandy, siliceous, hyperthermic Alfic Alaquods	Deep or very deep, poorl or very poorly drained, slowly permeable soils in flats, sloughs, and depressionsthat were formed in sandy and loamy marine sediments. The water table rises to within 6-18"of the surface for periods of 1-4 months annually and within 40" for more than 6 months.	Severe: wetness	TKN	20-40%	Shallow, fluctuating water table Moderately high organic content near surface in within a spodic horizon at depths >22"	
						NO3	>90%		
	1	2	**EMERALDA FINE SAND** Fine, mixed, superactive, hyperthermic Mollic Albaqualfs	Very deep, poorly drained, slowly or very slowly permeable fine sand to sandy clay soils in low areas near lakes and streams that were formed in clayey marine sediments. The water table is at depths of <10" for 6-9 months and saturated most of the year	Severe: flooding wetness percs slowly	TKN	10-30%	Very shallow water table High organic content in the surface horizon	
						NO3	>90%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	2	**FELDA FINE SAND** Loamy, siliceous, superactive, hyperthermic Arenic Endoaqualfs	Very deep, poorly drained and very poorly drained, moderately permeable fine sandy soils in drainageways and depressions that formed in stratefied, unconsolidated marine sands and clays. The water table is within 12" of the surface for 2-6 months each year.	Severe: ponding wetness poor filter	TKN	10-30%	Very shallow water table Moderate to high organic content in the surface horizon	
						NO3	40-60%		
	1	2	**GATOR MUCK** Loamy, siliceous, euic, hyperthermic Terric Haplosaprists	Very poolry drained organic soils that formed in moderately thick beds of hydrophytic plant remains overlying beds of loamy and sandy marine sediments. These soils are always saturated at or above the surface except during extended droughts.	Severe: ponding percs slowly poor filter	TKN	10-30%	Very shallow water table Low organic content below 34"	
						NO3	>90%		
	1	2	**IMMOKALEE FINE SAND** Sandy, siliceous, hyperthermic Arenic Alaquods	Deep and very deep, poorly drained and very poorly drained soils that formed in sandy marine sediments that occur in flantwoods and depressions. The water table is at depths of 6-18" for 1-4 months, 18-36" for 2-10 months and below 60" during dry periods.	Severe: wetness	TKN	20-40%	Shallow, fluctuating water table Moderately high organic content near surface	
						NO3	>90%		
	1	2	**MALABAR FINE SAND** Loamy, siliceous, active, hyperthermic Grossarenic Endoaqualfs	Very deep, poorly to very poorly drained soils in sloughs, shallow depressions and along flood plains in sandy and loamy marine sediments. The water table is within depths of 10" for 2-6 months during most years.	Severe: wetness poor filter	TKN	10-30%	Very shallow water table Low organic content	
						NO3	40-60%		
	1	2	**MYAKKA FINE SAND** Sandy, siliceous, hyperthermic Aeric Alaquods	Deep and very deep, poorly to very poorly drained soils formed in sandy marine deposit, which occur on flatwoods, flood plains, and depressions. The water table is at depths <18" for 1-4 month duration in most years and recedes to depths >40" during very dry seasons.	Severe: ponding wetness poor filter	TKN	40-60%	Shallow, fluctuating water table Moderate organic content	
						NO3	>90%		
	1	2	**NITTAW SANDY CLAY** Fine, smectitic, hyperthermic Typic Argiaquolls	Very poorly drained, slowly pwermeable soils that formed in thick deposits of clayey sediments of marine origin, which occur in drainageways, swamps and marshes. They are subjext to standing water above the soil surface for >6 months during late spring, summer and fall.	Severe: ponding percs slowly	TKN	10-30%	Very shallow water table High organic content in O and A horizons but diminishing quickly with depth Soil permeability slow in the sandy clay below A horizon	
						NO3	>90%		
	1	2	**OCOEE MUCK** Sandy or sandy skeletal, siliceous, dysic, hyperthermic Terric Haplohemists	Deep, very poorly drained soils that fromed in herbaceous organic material and sandy minera material, which occur on flood plains, fresh water marshes, and depressions.	Severe: subsides flooding wetness	TKN	5-20%	Very wet Deep O horizon from 0-38"	
						NO3	>90%		
	1	2	**OKEELANTA MUCK** Sandy or sandy skeletal, siliceous, euic, hyperthermic Terric Haplosaprists	Very deep, very poorly drained, rapidly permeable soils in large fresh water marshes and small depressional areas, which formed in decomposed hydrophytic non-woody organic material overlying sand. The water table is at depths of <10" below surface or ponded above surface.	Severe: flooding poor filter wetness	TKN	5-20%	Very wet Deep O horizon from 0-31"	
						NO3	>90%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	2	**ONA FINE SAND** Sandy, siliceous, hyperthermic Typic Alaquods	Poorly drained, moderately permeable soils that formed in thick sand marine sediments, which occur in flatwood areas. The water table is at depths of 10-40" for periods of 4-6 months. It rises to depths of <10" for periods of 12 months and may recede to >40" during very dry seasons.	Severe: wetness poor filter	TKN	10-30%	Shallow, fluctuating water table Moderate organic content above 20"	
						NO3	>90%		
	1	2	**PLACID FINE SAND** Sandy, siliceious, hyperthermic Typic Humaquepts	Very deep, very poorly drained, rapidly permeable soils on low flats, depressions, drainageways, and flood plains. The soils formed in sandy marine sediments. The water table ranges in depths from 0-6" for >2 months in most years.	Severe: ponding wetness poor filter	TKN	5-15%	Very shallow water table Moderatly high organic content above 18"	
						NO3	>90%		
	1	2	**POMPANO FINE SAND** Siliceous, hyperthermic Typic Psammaquents	Very deep, very poorlly drained, rapidly permieable soils occuring in depressions, drainageways and broad flats. The soils were formed in thick beds of marine sands. The water table is at depthso f >10" for 2-6 months each year and within depths of 30" for mor than 9 months.	Severe: ponding poor filter	TKN	5-15%	Very shallow, fluctuating water table Low organic content	
						NO3	40-60%		
	1	2	**SAMSULA MUCK** Sandy or sandy skeletal, siliceous, dysic, hperthermic Terric Haplosaprists	Very deep, very poorly drained, rapidly permeable soils that formed in moderately thick beds of hydrophytic plant remains underlain by sandy marine sediments. They occur in swamps and flood plains. The water table is at or above the surface except during extended dry periods.	Severe: ponding poor filter	TKN	5-15%	Very shallow water table Sapric soil materials from surface to 36"	
						NO3	>90%		
	1	2	**SANIBEL FINE SAND** Sandy, siliceous, hperthermic Histic Humaquepts	Very poorly drained sandy soils with organic surfaces, that formed in rapidly permeable marine sediments, which occur on nearly level and depressional areas. The water table is <10" deep for 6-12 months and is above ground surface 2-6 months during wet seasons.	Severe: ponding poor filter	TKN	5-15%	Very shallow water table High organic content in the O and A horizons to a depth of 10"	
						NO3	>90%		
	1	2	**SEFFNER FINE SAND** Sandy, siliceous, hyperthermic Aquic Humic Dystrudepts	Very deep, somewhat poorly drained, rapidly permeable soils on rims of depressions and on lower lying flats, which formed in sandy marine sediments. The water table is within depths of 18-42" for 2-4 months and within 60" for >9 months in most years.	Severe: wetness poor filter	TKN	5-15%	Very shallow water table Moderate organic content to 20"	
						NO3	>90%		
	1	2	**SMYRNA SAND** Sandy, siliceous, hyperthermic Aeric Alaquods	Very deep, poorly to very poorly drained soils fomremed in thick depsolits of sandy marine materials. The water table is at depths of >18" for 1-4 months and 1240" for more than 6 months	Severe: ponding poor filter	TKN	20-40%	Shallow, fluctuating water table Moderate organic content to 35"	
						NO3	>90%		
	1	2	**SPARR FINE SAND** Loamy, siliceous, subactive, hyperthermic Grossarenic Paleudults	Very deep, somewhat poorly drained, moderate slowly to slowly permeable fine sandy soils on uplands. They formed in thick beds of sand and loamy marine sediments. The water table is at depths of 20-40" for 1-4 months. The water table is usually perch on the loamy layers.	Severe: ponding poor filter	TKN	20-40%	Moderately shallow water table Low to moderate organic content	
						NO3	>90%		

Drainage Class	Water Table Class 1=<3.5 ft 2=>3.5 ft	Organic Matter Class 1=<1.0% 2=>1.0%	Soil Series Taxonomy	Soil Series Description	NRCS "Suitability" Rating for Onsite Treatment	Applied Nitrogen	Estimated TN Removal Potential	Comments	Source Documents
Somewhat Poorly / Poorly / Very Poorly	1	2	**ST. JOHNS FINE SAND** Sandy, siliceous, hyperhtermic TypicAlaquods	Very deep, very poorly or poorly drained, moderately permeable soils on broad flats and depressional areas. These soils formed in sandy marine sediments. The water table is 0-15" below surface for 20-50% of the year but is at 15-30" during periods of low rainfall.	Severe: wetness	TKN	20-40%	Shallow, fluctuating water table Spodic horizon with moderate organic content at 22-66"	
						NO3	>90%		
	1	2	**WABASSO FINE SAND** Sandy over loamy, siliceous, active, hyperthermic Alfic Alaquods	Deep or very deep, very poorly and poorly drained, very slowly and slowly permeable soils on flatwoods, flood plains, and depressions. They formed in sandy and loam marine sediments. The water table is at depths of 12-40" for more than 6 month and >40" during very dry seasons.	Severe: wetness poor filter	TKN	20-40%	Moderately shallow, fluctuating water table Low to moderate organic content	
						NO3	>90%		
	1	2	**WAUBERG FINE SAND** Loamy, siliceous, active, hyperthermic Arenic Albaqualfs	Poorly drained, very slowly permeable sandy soils that formed in thick beds of loamy marine sediments within large prairie areas and low areas within flatwoods. The water table is at depths of <10" for 3-5 months during most years.	Severe: wetness percs slowly	TKN	5-15%	Very shallow water table Sandy clay loam restrictive horizon at 24" Low to moderate organic content to 24"	
						NO3	40-60%		
	1	2	**WAUCHULA FINE SAND** Sandy over loamy, siliceous, active hyperthermic Ultic Alaquods	Very deep, very poorly or poorly drained, moderately slow or slowly permeable soils formed in sandy and loamy marine sediments. The water table is at depths of 6-18" for 1-4 month and 10-40" for as long as 6 months but receding to depths of 40" during the driest season.	Severe: wetness poor filter	TKN	5-15%	Shallow, fluctuating water table Low organic content	
						NO3	40-60%		
	2	2	**LOCHLOOSA FINE SAND** Loamy, siliceous, semiactive, hyperthermic Aquic Arenic Paleudults	Somewhat poorly drained, slowly permeable soils formed in thick beds fo sandy and loamy marine sediments. The water table is at depths of 30-60" for 1-4 months and recedes to >60" during the drier seasons.	Severe: wetness	TKN	20-40%	Moderatly deep, fluctuating water table Low to moderate organic content	
						NO3	40-60%		